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Original Article

Reconstruction after esophagectomy for esophageal cancer: Retrosternal or posterior mediastinal route?

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Abstract

Background: The aim of this study is to investigate which reconstructive route is most appropriate for patients undergoing an esophagectomy for esophageal cancer.
Methods: Clinical data on 110 patients were retrospectively collected by reviewing their medical charts. In order to evaluate the effects of adjuvant radiotherapy, patients were interviewed about the adverse side effects they experienced during and after treatment.
Results: The leakage rate was significantly lower in group that received posterior mediastinal reconstruction compared with the group that received retrosternal reconstruction (7.1% vs. 39%, $p = 0.01$). There were no significant differences between groups in terms of side effects related to adjuvant chemoradiotherapy or radiotherapy. The quality-of-life reports of patients who received adjuvant radiotherapy were not significantly different between the two study groups.
Conclusion: For patients with esophageal cancer who undergo an esophagectomy followed by gastric conduit reconstruction, the posterior mediastinal route is superior to the retrosternal route in regard to anastomotic leakage and hospital mortality. Adjuvant radiotherapy did not influence the postoperative functions of the gastric conduit used for reconstruction in either route.

Keywords: complication; esophageal cancer; reconstruction

1. Introduction

Esophageal carcinoma is an aggressive malignancy with a poor clinical prognosis. Although there are an increasing number of therapeutic options that can be used to treat esophageal cancer, surgical resection remains the mainstay of treatment. Esophageal resection for esophageal cancer is usually performed in two steps: cancer resection followed by reconstruction in order to allow the patient to eat food normally. The stomach is the most commonly used substitute for reconstruction after esophagectomy.[1–3] Usually, there are multiple options for the placement of the gastric conduit: the retrosternal, posterior mediastinal, subcutaneous, right intrathoracic, and left intrathoracic routes are often used.[4] Among these, the retrosternal and posterior mediastinal route are the most commonly used for reconstruction after esophagectomy.[5–7] Some studies have reported the advantages and disadvantages of these reconstructive routes after esophageal resection. The posterior mediastinal route has lower reported rates of morbidity and mortality after surgery.[8,9] For esophageal carcinoma, complete eradication of the disease by esophageal resection and lymph node dissection can only be achieved in a small proportion of patients. Great interest has been directed toward the use of multimodalities, including adjuvant chemoirradiation, to better treat this disease. The use of chemoradiotherapy after radical resection has been

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used to effectively reduce the local/regional recurrence of this disease.[10–14] However, the side effects of radiotherapy on the bypass conduit are a great concern for patients who must undergo reconstruction via the posterior mediastinal route. Few studies have been reported in the literature that investigated the effects of postoperative radiation on the gastric conduit and how this impedes swallowing functions in patients after reconstruction. The aim of this study is to evaluate postoperative morbidities, including the anastomotic leakage rate and other side effects caused by adjuvant radiotherapy, in patients who undergo esophageactomy for esophageal cancer followed by reconstruction via either the retrosternal or posterior mediastinal route.

2. Methods

From January 2006 to December 2008, esophagectomies for esophageal cancer were performed in 113 patients at Taipei Veterans General Hospital. Among these patients, three patients who had reconstruction with a segment from the colon were excluded from this study. All patients had a complete preoperative check-up that included an esophagogastroscopy, computed tomography (CT) of the chest and upper abdomen, pulmonary function tests, and, in those suspected of having metastatic cancer, a whole-body positron emission tomography (PET) scan. The approaches for performing an esophagectomy include right transthoracic, video-assisted thoracoscopic surgery (VATS) and transhiatal and left-side thoracoabdominal approaches; the decision regarding which approach is most appropriate depends on the location of tumor, the depth of the tumor invasion, and the surgeon's preference. For patients who underwent the transthoracic approach (open thoracotomy or VATS), the retrosternal route was routinely used for reconstruction unless short gastric tubes were noted during the operation. For patients who underwent the transhiatal or thoracoabdominal approach, the posterior mediastinal route was used for reconstruction. To restore the continuity of the gastrointestinal tract after an esophagectomy, the stomach was used as the conduit for reconstruction in all patients enrolled in this study. The gastric conduit is made by immobilizing the stomach and forming a gastric tube by resection stapling of the lesser curvature, during which the left gastroepiploic artery, left gastric arteries, and short gastric artery are subsequently ligated and divided and the branches of the right gastroepiploic artery and right gastric artery are preserved. The gastric conduit is then pulled up to the neck through either the retrosternal or posterior mediastinal route. In patients who underwent the transhiatal approach or left-side thoracoabdominal approach for esphagectomy, reconstruction through the posterior mediastinal route was performed. Anastomosis was conducted in the neck of each patient using the hand-sewing technique. A jejunostomy feeding tube was routinely used at the end of the operation. Clinical data, including postoperative complications (anastomotic leakage, prolonged ventilation, pneumonia, chylothorax, postoperative bleeding, myocardial infarction, etc.), intra-operative blood loss, operation time, time spent in the ICU, time required before extubation after surgery, and mortality were retrospectively collected by reviewing the medical charts of each patient. Patients were weaned off their ventilators when they met the necessary criteria, and they were transferred back to the ward the next day. The definition of anastomotic leakage was the evacuation of saliva from neck wound, and prolonged ventilation was defined as the need for mechanical ventilation for more than 7 days in the ICU. Patients with lymph node metastasis received adjuvant chemoirradiation. The chemoirradiation protocols and dosages were similar in all patients, including the administration of radiation dosages up to 5000 cGy and cisplatin-based chemotherapy. Contrast- or transit-time studies, in order to evaluate the functions of the gastric tube, were not routinely performed during the postoperative period. To evaluate the effect of adjuvant radiotherapy on the conduit during the postoperative period, the patients were interviewed and asked questions regarding the adverse effects of radiation during treatment. The questionnaire used was modified from that used by Aaronson et al.[15] Statistical differences between these two groups were determined using the $\chi 2$, Fisher's exact, or independent t test; $p < 0.05$ was considered significant.

3. Results

The clinical data on the 110 patients who underwent an esophagectomy and reconstruction for esophageal squamous cell carcinoma (ESCC) are shown in Table 1. The pathological diagnoses of the 110 patients included squamous cell carcinoma (103 patients), adenocarcinoma (1 patient), malignant melanoma (1 patient), spindle cell carcinoma (1 patient), carcinosarcoma (2 patients), adenosquamous carcinoma (1 patient), and mucoepidermoid carcinoma (1 patient). There were 100 male and 10 female patients enrolled in this study. Their ages ranged from 38 years to 89 years, with a mean age of 61 years. Eighty-two patients underwent reconstruction via the retrosternal route

Table 1
Clinical data on 110 patients who underwent esophagectomy at Taipei Veterans General Hospital, 2006–2008.

Variables	No. (%)
Number of patients	110
Age (years, mean)	38–89 (61.3 ± 12.3)
Gender	
Male	100 (90.9)
Female	10 (9.1)
Reconstructive route	
Retrosternal	82 (74.5)
Posterior mediastinal	28 (25.5)
Leakage	
Yes	34 (30.9)
No	76 (69.1)
Pathological stage	
Stage I	19 (17.3)
Stage II	35 (31.8)
Stage III	42 (38.2)
Stage IV	14 (12.7)
Adjuvant radiotherapy	
Retrosternal	42 (38.1)
Posterior mediastinal	12 (10.9)

(RS group) and 28 patients via the posterior mediastinal route (PM group). Most of the tumors were located in the middle to lower third of the esophagus. Anastomotic leakage was noted in 34 patients (30.9%). Fifty-four patients, including 42 patients in the RS group and 12 patients in the PM group, received adjuvant radiotherapy. Table 2 shows the results of comparisons between the RS and PM groups. Patients who underwent the posterior mediastinal route were older than patients who underwent the retrosternal route ($p = 0.007$). There were no significant differences in terms of the tumor location or stage between these two groups. In the PM group, most of the patients underwent the left-side thoracoabdominal or transhiatal approach for esophagectomy ($p < 0.001$). The leakage rate was significantly lower in the PM group than in the RS group (7.1% vs. 39%, $p = 0.01$). In addition to a higher incidence of leakage, the RS group required a longer operative time and time to extubate and had a higher mortality rate compared to the PM group (Table 3). There were two patients in the RS group who suffered from postoperative bleeding that required an additional operation. One patient was found to have bleeding due to the thoracotomy, and the other patient had bleeding in the retrosternal tunnel. Tables 4 and 5 show the results of the interviews and the questions that were asked regarding quality of life following adjuvant radiotherapy. There were no significant differences between groups in terms of side effects caused by concurrent adjuvant chemoradiotherapy or radiotherapy. All patients in both groups who received adjuvant chemoradiotherapy were able to finish the entire course of treatment. Quality-of life-reports after adjuvant

Table 2
Comparison of patients who underwent reconstruction via the retrosternal or posterior mediastinal route after esophagectomy.

	Retrosternal	Post. mediastinal	*p*
Number of patients	82	28	—
Mean age (years)	59.5 ± 11.4	66.7 ± 13.5	0.007*
Male/Female	75/7	25/3	0.492
Tumor location			
Upper third	5	2	0.069
Middle third	49	10	
Lower third	28	16	
Pathological stage			
Stage I	11	8	0.233
Stage II	28	7	
Stage III	31	11	
Stage IV	12	2	
Approaches for esophagectomy			
Right thoracotomy or VATS	81	10	<0.001*
Left thoracoabdominal or transhiatal	1	18	
Adjuvant chemoradiotherapy			
Yes	42	12	0.514
No	40	16	
Anastomotic leakage			
Yes	32 (39%)	2 (7.1%)	0.001*
No	50 (61%)	26 (92.9%)	

*$p < 0.05$.

Table 3
Comparison of postoperative morbidity and mortality in patients who underwent retrosternal or posterior mediastinal reconstruction after esophagectomy.

	Retrosternal ($n = 82$)	Post. Mediastinal ($n = 28$)	*p*
Operative times (minutes)	528.6	439.2	0.001*
Blood loss (mL)	556.6	488.9	0.379
Major complication (%)			
Anastomotic leakage	32 (39.0)	2 (7.1)	0.001*
Prolonged mechanical ventilation (>7 d)	12 (14.6)	2 (7.14)	0.250
	2 (2.4)	1 (3.5)	0.590
Pneumonia	3 (3.6)	1 (3.5)	0.732
Chylothorax	2 (2.4)	0	—
Postoperative bleeding	1 (1.2)	0	—
Myocardial infarction	4 (4.8)	1(3.5)	0.021*
Hospital mortality			
ICU stay (d)	8.5	7.1	0.390
Hospital stay (d)	25.5	23.6	0.518
Time to extubation (d)	4.7	3.7	0.048*

*$p < 0.05$.

Table 4
Side effects encountered during treatment of patients who received concurrent adjuvant chemoradiotherapy.

	Retrosternal ($n = 21$)	Post. mediastinal ($n = 8$)	*p*
Hematemesis			
Yes	0	1	0.276
No	21	7	
Chest pain or tightness			
Yes	4	2	0.543
No	17	6	
Vomiting/nausea			
Yes	2	1	0.636
No	19	7	
Poor appetite			
Yes	12	2	0.129
No	9	6	
Weakness			
Yes	16	1	0.003
No	5	7	
Dyspnea			
Yes	4	1	0.575
No	17	7	
Difficulty swallowing			
Yes	12	3	0.298
No	9	5	
Sleep problems			
Yes	9	2	0.330
No	12	6	
Constipation			
Yes	3	0	0.364
No	18	8	
Diarrhea			
Yes	3	0	0.364
No	18	8	
Treatment completed (%)	100%	100%	—

Table 5
Evaluation of quality-of-life reports completed by patients who underwent esophagectomy followed by adjuvant concurrent chemoradiotherapy.

	Retrosternal ($n = 21$)	Post. mediastinal ($n = 8$)	p
What kinds of the food can you eat?			
Solid	15	6	0.618
Soft	6	2	
Liquid	0	0	
Do you suffer from regurgitation?			
Yes	14	6	0.517
No	7	2	
Did you receive esophageal dilatation?			
Yes	12	3	0.298
No	9	5	

radiotherapy were not significantly different between these two groups.

4. Discussion

For patients who require an esophagectomy for esophageal cancer, the route for reconstruction is often debated. Some surgeons recommend the retrosternal route because it offers some advantages. The use of this route can avoid the effects of irradiation to the conduit during adjuvant radiotherapy.[6] Van Lanschot and colleagues concluded that in patients at high risk of developing secondary malignant dysphagia, the extra-anatomical route is the best choice.[7] Wong and associates reported that recurrent tumor infiltration of the gastric conduit occurs in 14% of patients when the orthotopic route is used.[16] Katsoulis et al reported that retrosternal interposition can minimize reflux compared with the use of the posterior mediastinal route. Reflux of the contents of the duodenum following posterior mediastinal reconstruction is less severe.[17] In addition, the retrosternal route has been advocated as a way to decrease the risk of postoperative pneumonia because distention of the stomach with air and/or fluid in the early postoperative period does not compress the lungs.[18] In contrast, some authors advocate the use of the posterior mediastinal route because it is shorter and results in fewer cardiopulmonary complications and anastomotic leaks, which may be related to its lower rates of hospital mortality.[4,5,19,20] A meta-analysis of six randomized controlled trials by Urschel and colleagues, however, reported that the posterior and anterior mediastinal routes are associated with similar outcomes after esophagectomy for cancer.[21] In our study, 103 of 110 patients with esophageal cancer were diagnosed with squamous cell carcinoma. Most of these patients received a right thoracotomy for esophagectomy with reconstruction via the retrosternal route. When the tumor was located in the lower third of the esophagus or if the patient had poor cardiopulmonary functions, the left thoracoabdominal or transhiatal approach was performed with reconstruction via the posterior mediastinal route. The data from our retrospective review shows that the rate of anastomotic leakage was significantly higher in patients who underwent the retrosternal route compared with those who underwent the posterior mediastinal route. A higher operative mortality was also noted in the group of patients that underwent the retrosternal route. Some authors have also demonstrated a significantly higher rate of leakage following reconstruction via the retrosternal route.[3,20] In addition to anastomotic leakage, bleeding has been reported as a uncommon side effect when creating the substernal tunnel.[1] In our study, one patient experienced postoperative bleeding in the retrosternal tunnel, which necessitated an additional operation. In addition, the patients in the PM group were older than the patients in the RS group in this study. This may be because some of the patients who underwent posterior mediastinal reconstruction had undergone a transhiatal esophagectomy, and these patients are likely to be older and have poorer pulmonary functions.

The incidence of anastomotic leakage in patients who underwent reconstruction via the retrosternal route after esohpagectomy has been reported to range from 2.1% to 70%.[15,20,22] It has been reported that nearly 50% of cervical anastomotic leaks result from anastomotic strictures and the subsequent need for chronic dilatations, which negate the merits of an operation intended to restore comfortable swallowing.[23] Some authors have suggested that the increased risk of anastomotic leakage in patients who undergo retrosternal reconstruction is due to the additional length of reconstruction that is required if anastomosis is made over the neck and the tight angulation of the thoracic inlet.[1,4] In order to facilitate exposure and to avoid compression of the gastric tube when it is brought up to the neck during retrosternal reconstruction, some author favor removal of a portion of the manubrium, associated costal cartilage, and the medial portion of the left clavicle.[1,4] In this study, most of the tumors were located in the middle third of the esophagus. To obtain better clinical results, anastomosis after esophageactomy was carried out at the neck without removal of the manubrium. Blunt dissection was performed in order to enlarge the thoracic inlet as much as possible and avoid compression of the gastric conduit; however, leakage was still noted in up to 39% of patients who underwent the retrosternal route. Regarding whether a different approach would affect the leakage rate, 91 patients of 110 patients in this study underwent the transthoracic approach for esophagectomy (including right-side thoracotomy and VATS). Eighty-four patients underwent right-side thoracotomy and only seven patients underwent a minimally invasive procedure for esophagectomy. It has been reported that there are no significant differences in terms of postoperative outcomes, including the leakage rate and hospital mortality, between patients who undergo open thoracotomy and minimally invasive procedures.[24–26] In this study, the leakage rates of these two groups of patients were not different.

Another concern regarding which route patients should undergo for reconstruction is the possible effects of adjuvant chemoirradiation. Few studies in the literature have discussed whether the effects of radiation would influence the functions of the gastric substitute. Gawad and associates recommend the posterior mediastinal route, but suggest that curative resection be mandatory in order to avoid possible complications due to local recurrence. After incomplete resection, retrosternal reconstruction is recommended for better palliation.[9] Kunisaki and

colleagues also concluded that retrosternal reconstruction should be considered as the adopted method of choice after palliative esophagectomy because of the need for further radiotherapy.[27] However, even with complete resection, tumor recurrence after esophagectomy for esophageal cancer is common, which further necessitates the need for adjuvant therapy to decrease the likelihood of local recurrence.[10,13,28] In this study, in order to evaluate the radiation-induced adverse side effects, we interviewed the patients who underwent either retrosternal or posterior mediastinal reconstruction about swallowing functions in the postoperative period. We found that there were no significant differences between the two groups in terms of radiotherapy-related adverse effects, quality of life after radiotherapy, or the need for further esophageal dilatation. The reason that more patients in the RS group felt weakness may be because these patients had poor appetites and swallowing difficulties, although these findings were not statistically significant. Most importantly, all of these patients could tolerate and complete the whole course of adjuvant radiotherapy.

There are some limitations to this study. Because this study is retrospective, we are not able to thoroughly evaluate swallowing functions in all patients who underwent an esophagectomy for esophageal cancer. Also, only patients who underwent esophagectomies in the past 3 years were enrolled in the study; therefore, it was difficult to investigate the relationship between tumor recurrence and secondary dysphagia that patients might encounter in the follow-up period. Future studies with a larger patient cohort and longer follow-up period may be needed to elucidate the effects of adjuvant radiation on the gastric substitute and quality of life in patients who undergo an esophagectomy.

In conclusion, for patients with esophageal cancer who require an esophagectomy followed by gastric conduit reconstruction, the posterior mediastinal route is superior to the retrosternal route in regard to anastomotic leakage and hospital mortality. Adjuvant radiotherapy did not influence the postoperative functions of the gastric conduit used in either reconstructive route. We suggest that for patients who have undergone curative resection for esophageal cancer, reconstruction with a gastric tube via the posterior mediastinal route should be considered.

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